CONTACT INFECTION.

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In order to successfully combat the contagious diseases it is of the utmost importance that we should know their mode of transmission. Yet it is surprising how little accurate knowledge we possess. We do know that yellow fever and malaria are transmitted solely by the bite of mosquitoes, but we have very few definite data as to the mode of transmission of our common diseases such as diphtheria, scarlet fever, measles, smallpox, typhoid fever and tuberculosis. The last named disease well illustrates these unsatisfactory conditions. Some of the highest authorities claim that tuberculosis is nearly always acquired by drinking the milk of tuberculous animals, others equally eminent, think that this almost never occurs; some believe that tuberculosis is caused by the inhalation of dried and pulverized sputum, while others think that such dust is practically innocuous, and lay great stress on "droplet infection." As regards most other contagious diseases there is an almost equal lack of exact knowledge. In the absence of definite knowledge various theories are current on which our preventive measures are based. Among assumed modes of transmission may be mentioned that by insects, in which the insect may be either the host, or merely the carrier of pathogenic organisms. This has been proved to be the sole mode of transmission of malaria and yellow fever and of some importance, and perhaps of very great importance in plague, but for the ordinary diseases of the temperate zone there is little evidence that this mode of infection is a real factor. The assumed relation of typhoid fever and flies is certainly not proved, and for civil conditions there is some evidence that flies play little or no part in the transmission of this disease.

Infected food and drink have considerable proved importance, particularly in typhoid fever, dysentery, cholera and summer diarrhoea, but this importance has been over, rather than under-rated.

Infection by means of the inspired air has probably always been held to be the chief factor in the spread of the contagious diseases. Aerial infection is variously explained, or as in the case of the alleged long distance infection from smallpox hospitals no attempt is made to explain it. Close range infection, that is at the distance of two or three feet is explained as due to Fluegge's droplets; infection in the room, the house, or the hospital ward, is supposed to be due

to dried infective material floating as dust. There is not time here to discuss this theory of infection by inspired air, but I have found very little evidence of its importance and much against it.

Another theory may be called that of infection by fomites. This assumes that various articles used by a sick person, or standing in the sick room, become infected, and retain the infection for long periods of time, so as to infect those who then handle them. The health officer and the public have set much store by this theory, and though it has been proved entirely false as regards that disease in which its importance was supposedly demonstrated beyond a doubt, namely, yellow fever, it is still put forward to explain the spread of our common infections. Just here I want to emphasize a distinction which is made by everybody though it is not found in the dictionaries. An infected book, or dress, or toy, that is put away, and used weeks or months afterwards is the sort of thing which is thought of when fomites are mentioned; a cup or a pencil which moistened with secretion is used by another within a few minutes or perhaps an hour or two, are rarely considered fōmites. The latter may be of great importance in the transmission of infection, while the former may, and I believe are of very little importance.

This leads us to the consideration of another mode of infection to which of late increased importance is being attributed. This is frequently spoken of as "contact infection." It is not easy to define this term with accuracy, but it is used as signifying a quite direct transference of quite fresh secretions or excretions from the sick to the well, either immediately as in kissing or mediately on fingers, cups, spoons, etc. There are excellent reasons why the former aerial and fōmites theories met with favor, and why they are now being supplanted by the contact theory. The large majority of cases of contagious disease are never traced to their source. It was naturally assumed that they must have come from the known cases, hence the infection was assumed to have been borne by the air or carried in some circuitous way by fomites. We now have no occasion to assume any such mode of transmission, and the data of bacteriology as well as much other evidence is against it. One of the most important results of the experimental work of the last quarter of a century is the discovery of the frequent occurrence and long duration of carrier cases, that is, well persons in whom disease germs are growing. Moreover bacteriology has demonstrated that there is no hard and fast line between the cases of well developed diseases, and the mere carriers. We now know that there is a series of grading from the fatal cases to those of the mildest type, of such mildness that they cannot be recog-

nized except by laboratory methods, and rarely are recognized. We know that the mild cases and the carrier cases exceed the reported cases in number, and we are justified in assuming that the reported cases arise by "contact infection" from the mild and carrier cases, and not by around-about aerial or fomites infection from the reported cases. The wonder is, not that we have so many untraced cases of contagious disease but that we do not have more. The demonstration of the importance of these mild and carrier cases has not as yet had much influence on sanitary practice, but it is certainly destined to in the near future. Most persons shut their eyes to the facts. It is easier to do so than change ideas and methods. Those who deny the frequency of these unrecognized sources of infection will probably cling to the old ideas in regard to the mode of transmission.

Fifteen years ago it was generally believed that typhoid fever was caused by infected drink or infected air, and if the latter, sewer air was usually the assumed factor. My own attention was first called to the importance of contact infection in this disease by a report by Sedgwick on an outbreak at Bondville, Mass. in 1892. His graphic description of the careless disposal of excreta, and the filthy habits of the people clearly showed that there was no need for assuming any other source for the outbreak than a pretty direct transference from person to person. Similar observations were made by Koch in an outbreak invesigated by him at Trier in 1903.

The very valuable report on typhoid fever in our army during the Spanish war, and the observations of the English in the Boer war, indicate very clearly contact infection as the chief factor in camp typhoid. Jordan's report on typhoid in Winnipeg also laid great stress on this mode of infection, and many recent writers in Germany and in this country are attributing great importance to it. It is my own opinion that the larger part of the typhoid fever in the United States to-day is caused in this way. Certainly only a small part is due to infected water or milk, and still less to infected air. The great number of convalescents who are excreting the bacilli in their urine while freely mingling with the public, and the great number of carrier cases, like the woman recently discovered in New York, are amply sufficient to cause most of our typhoid by contact, particularly when their excreta are in so many instances stored in an old fashioned privy vault or discharged directly on the ground.

Many years ago, from the study of conditions in my own city I began to be skeptical as to the importance both of the air and of fomites as ordinarily understood, as vehicles of infection in scarlet fever and diphtheria. In houses containing more than one family,

these diseases in a majority of instances affect only one family, although stairs, hallways, cellars, and often water closets and privies, are used in common. If the virus of these diseases was nearly as tenacious of life as is supposed, it would often be carried by the air, or by means of stair rails and door knobs, transmitted to the other families. But in Providence of 3542 "other families" in the house with scarlet fever only 7.5 per cent were infected, and in diphtheria of 2,903 families only 7.2 per cent. Furthermore, investigation shows that when the disease does extend from family to family, personal contact is found to have taken place. The frequency with which a case of scarlet fever or diphtheria can remain for days in a school without causing other cases, indicates that infection is not so easily transmitted as is generally supposed. Quite close contact is probably necessary. If there were no unrecognized cases and no carriers, it would be easy, as indeed it was formerly believed to be, to stamp out these diseases, by a very moderate degree of isolation. That contact of some sort is necessary is shown by the fact stated by Welch and Schamberg that of 700 medical students who have visited the scarlet fever wards of the Philadelphia Hospital not one has contracted the disease, though fully half the number had never had it. Dr. Schamberg writes me that about the same number visited the diphtheria wards with a like result. These men breathed the air of the wards for one or two hours but were instructed to keep hands off.

A most interesting experiment as to modes of infection is being carried on in a number of hospitals, chiefly in Europe, which, however, does not seem to have attracted much notice in this country. The most perfectly equipped of these hospitals is the Pasteur Hospital in Paris. This hospital was opened in 1900 and the essential feature of its management is that contact infection is guarded against by every possible precaution, while aerial infection is disregarded. Since this hospital was opened several thousand cases of smallpox, measles, diphtheria, scarlet fever, as well as other contagious and non-contagious diseases, have been treated there in rooms opening into a common corridor and attended by nurses who passed directly from one disease to another. There have been less than a dozen transfers of disease, a wonderful showing, much better than in the very best of hospitals as ordinarily managed, where every effort is made to prevent aerial infection, and where separate nurses are provided for each disease, but where nurses and doctors are not trained to guard against contact infection. All articles that come out of these rooms or cubicles are sterilized, and whatever goes in is sterilized (at least so far as specific infections are concerned.) The attendants wear

gowns but do not change them in passing from patient to patient unless they become infected by contact with bed or patient. The nurse often enters the room to speak to the patient, or carry some article without infecting dress or hands, and so may safely go to another patient without washing her hands, but if anything in the cubicle is touched the hands are at once disinfected. The success of this method depends upon the training of doctors and nurses. They practice what the French call medical asepsis, along the same lines that our surgeons perform operations. Formerly air infection chiefly, was feared in the operating room, but the danger is now known to be from contact with hands, instruments, dressings and the patient's skin. So high an authority as Ochsner says that aerial infection is a neglible quantity. Contact infection only is to be guarded against. Some say that the cubicles, even if the doors do remain open, prevent much aerial infection, and to this is due the success of the Pasteur Hospital. But other European hospitals make use of low screens between the beds with substantially as good results. In fact cubicles or screens are valuable chiefly for their moral effect on attendants, and with scrupulous care to prevent contact infection, it is possible to treat measles, scarlet fever and diphtheria in an open ward without cross infection. Measles is generally considered a very infectious air borne disease, but the French physicians are satisfied from their experience that it extends almost exclusively by contact infection.

There is no opportunity in a brief paper like this to set forth all the arguments against what may be called the aerial and fomites theories of infection, or to present in detail the reasons for considering contact infection as the chief factor in the spread of the contagious diseases. Indeed there is no need of doing so at a meeting like this. You are probably well aware of the trend of observation, experiment and practice. This paper is to emphasize the need for educating the medical profession and the public. That there is such need I can well attest. Thus at one of the finest hospitals in this country with separate wards for scarlet fever and diphtheria a considerable number of cases have arisen in the general wards. The germs were supposed to be air borne, as it was said there was no other possible avenue of infection. When I saw the head nurse lick her finger to facilitate turning the bedside charts of diphtheria patients, I suspected that the principles of medical asepsis had not been entirely mastered. Called to see a case of scarlet fever in a well to do family, I found the door of the sick room carefully hung with a sheet to keep the infection from the other children. After examining the throat with a spatula I handed the latter to the mother. She took it into the hall and put it

on an upholstered sofa, and with her saliva infected hands opened the door of an adjoining room. The attending physician meanwhile sat on the bed and handled the patient, an entirely unnecessary proceeding at that time, and except for example set him, would have forgotten to wash his hands before leaving. A certain hospital determined to copy in one of its wards the cubicle system of the French, but had so missed its essential features that I found doctors and nurses going from cubicle to cubicle feeling the pulse, smoothing the bed clothes, and handling dishes without ever stopping to wash their hands. Meanwhile the screen was supposed to prevent the microbes from passing from bed to bed, and we all carefully wore gowns and caps so that the wicked little germ, might not jump into our hair and then jump off again on to the next patient. In another fine hospital for contagious diseases, where great stress is laid upon ample space between different diseases so as to prevent cross infection, the superintendent was observed to freely touch articles about the ward, and handle the patients, and then go to the public office without even washing his hands. Such incidents could be multiplied indefinitely. There is ample room for improvement in the management of contagious diseases. We must teach those who have the care of the sick not to waste so much time on the invisible, dry and dead micro-organisms of the air, but to use more soap and water on their hands. Better still, try not to infect the hands or clothes in the sick room. There is a great deal of unnecessary handling of the patient, and infected articles, by health officers, physicians and nurses. In visiting a contagious case as consultant I almost never wear a gown, and often do not even infect the hands. By paying more attention to contact infection, isolation in the family and hospital will be easier and more successful.